Application Note

AM3: Raw syngas – primary reformer outlet

Industry: Ammonia
Application Note AM3

Key Points

- Unique spectroscopic capability to measure all syngas components, including H_2 and N_2
- Pipe-centric sampling and measurement at the sample tap
- The OptoDRS Sampling System is a unique front end to allow measurement at process P and T
- Complete syngas speciation
- No valves, columns, or carrier gas
- No routine calibration required
- No interference from moisture vapor in the raw syngas sample after preconditioning by the OptoDRS

Raw syngas is the first intermediate product formed by the partial oxidation of natural gas in a Steam Methane Reformer (SMR). Measurement of the syngas components (H_2, CO, CH_4 and CO_2) are used to monitor the H_2 and CO yield to allow adjustments of the steam/carbon ratio for controlling the reformer.* The major analytical challenge for measuring this raw syngas stream is the high temperature and steam saturated sample, which traditionally have been a major problem in performing reliable sampling and analysis.

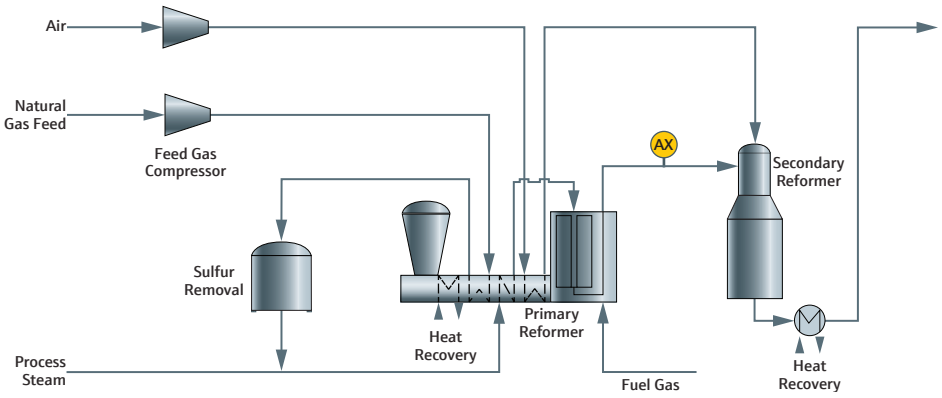

Figure 1: Primary Steam Reformer Section of Ammonia Plant Process Units**

Measurement of raw syngas The Optograf™ Analyzer combined with an OptoDRS™ process and sampling interface is a unique solution to the sampling and analysis of this particular process stream. A typical Optogram spectrum for a steam reformer syngas stream is shown in the Figure 2. Note the simplicity and complete speciation of H_2, CO, CO_2 and CH_4 as individual spectral peaks in the Optogram. Any residual moisture still present in the stream after condensation in the OptoDRS sampling interface is not visible in the frequency range of the spectrum. Hence, it cannot interfere with the analysis, and a dry basis result is provided. The measurement is based on a normalized analysis, which makes it a very robust analysis against pressure, temperature, flow and other changes as well as any slow fouling that may occur.

Reliability Issues with traditional methods for syngas analysis Syngas is typically measured with process Gas Chromatography (GC) or Mass Spectrometry (MS). Both technologies require transporting and conditioning the sample at both the sample tap and sample conditioning panel close to the analyzer. In the case of the primary reformer outlet stream, the use of a Dynamic Reflux Sampler (DRS) or alternative liquid removal system is mandatory. Protecting the GC or MS analyzers from liquid carry-over is the main challenge as this event can damage columns in a GC or damage the ionization chamber in a MS. The AirHead™ probe cannot be damaged by liquid carry-over or fouling and cleaning is simple and straightforward.

* See the Measurement of the Natural Gas Feed to the Reformer Application Note (AM1).
** See the general Ammonia Production Overview Application Note (AM0).

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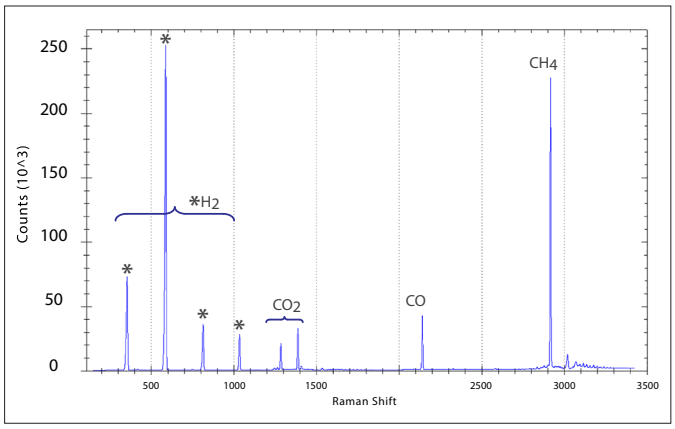

Figure 2: Typical Optogram Spectrum for Syngas

The solution: Optograf™ Analyzer raw syngas – primary reformer outlet application kit. The use of a liquid removal system is mandatory for the primary reformer outlet stream (see Figure 1), which is saturated with steam at high temperatures (typically 700-800°C, but as low as 200-350°C at the sample tap). The OptoDRS process and sampling interface is a preconditioning liquid condenser (typically vortex cooled using instrument air) and a sample conditioning system including an AirHead™ probe as a fully integrated sampling and sensor measurement system located at the sample tap. This pipe-centric configuration is unique for this type of stream and essentially eliminates the potential for liquid carry-over. As such, it is a significantly more reliable sampling and measurement front-end, which overcomes the traditional dilemma of the analyzer performance being totally dependent on the performance of the sampling system.

The Optograf Raw Syngas – primary reformer outlet application kit consists of the following:

- Laser Module with installation kit
- AirHead™ Fiber Optic Probe
- Fiber Optic Cable (length from 15 to 150 meters, customized to your plant requirements)
- Dedicated syngas primary reformer outlet Method

Typical Process Conditions	P (barg)	T (°C)
At Sample Tap	35	800
At AirHead™ Probe	35	55

Typical Stream Composition

Component	Range (Mol%)	Normal (Mol%)	Precision (Mol%) k=2	Cal Gas (Mol%)	Precision (Mol%) k=2
Hydrogen	40-95	67.2	0.03	64	0.03
Nitrogen	0-35	0.7	0.01	16	0.03
Carbon Monoxide	0-35	9	0.02	7	0.01
Carbon Dioxide	0-30	10.6	0.02	10	0.02
Methane	0-35	12.5	0.01	3	0.01
Argon	0-2	0.7	N/M	0	N/M

Table 1: Typical Process Conditions and Stream Composition

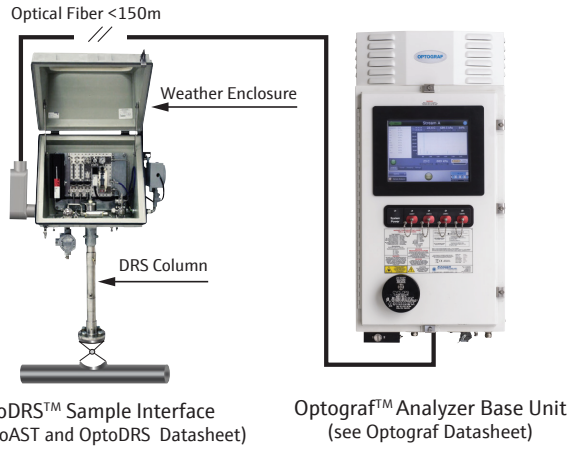

Figure 3: Recommended System Configuration

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